

In re Appln. of Brian Christian Orr et al.
Serial No. 10/028,242
Reply To Office Action Of December 18, 2003

REMARKS

In the Office Action dated December 18, 2003, the Examiner:

(a) withdrew the indicated allowance of Claim 6 in view of a new found reference, JP 61-149,652;

(b) rejected Claim 6 as being unpatentable over Applicant Prior Art, Figure 2, in view of Glaze et al. (US 4,733,578);

(c) rejected Claims 1, 3-6, and 8-10 under 35 U.S.C. 102(b) as being anticipated by Iwata (JP 61-149652);

(d) rejected Claim 2 under 35 U.S.C. 103(a) as being unpatentable over Iwata (JP 61-149652);
and

(e) rejected Claims 1-6 and 8-10 under 35 U.S.C. 103(a) as being unpatentable over Applicant Prior Art, Figure 2, in view of Glaze et al. (US 4,733,578).

By this response, Applicants respectfully traverse the rejections of: Claims 1, 3-6, and 8-10 under 35 U.S.C. 102(b) as being anticipated by Iwata; Claim 2 under 35 U.S.C. 103(a) as being unpatentable over Iwata; and the rejection of Claims 1-6 and 8-10 under 35 U.S.C. 103(a) as being unpatentable over Applicant Prior Art, Figure 2, in view of Glaze et al. For the reasons stated herein, Applicants submit that each of the pending and non-withdrawn claims (Claims 1-6 and 8-10) are in condition for allowance.

In the Examiner's explanation of the rejection of Claims 1, 3-6, and 8-10 under 35 U.S.C. 102(b) as being anticipated by Iwata (JP 61-149652), the Examiner references a marked-up copy of Figure 2 of Iwata attached as Exhibit 1 to the Office Action. Applicants have provided herewith a translation of the Iwata (JP 61-149652) reference along with an Affidavit of the translator. As indicated in page 3, paragraphs 2 and 4, of the translated reference, Iwata discloses spherical seat surfaces 6a-6d which are

coaxial. As such, with respect to Claim 1, Applicants respectfully submit that Iwata fails to disclose "a centerpoint of said at least one spherical surface is substantially collinear with said axle centerline and is offset from the centerpoint of said chamber by an offset distance along said axle centerline in a direction away from said opposing surface such that said at least one spherical surface is closer to said centerpoint of said at least one spherical surface than said chamber centerpoint." With respect to Claim 3, Applicants respectfully submit Iwata fails to disclose "a differential chamber having a chamber centerpoint, said differential chamber formed by offsetting the spherical centerpoint of said first gear from the chamber centerpoint in a direction away from the surface of said second gear." With respect to Claim 4, Applicants respectfully submit that Iwata fails to disclose "said second radius centerpoint is substantially collinear with said axle centerline and offset from said casing centerpoint an offset distance along said axle centerline in a direction away from said first inner radius." With respect to Claim 6, Applicants respectfully submit Iwata fails to disclose "each of said part-spherical regions comprising part of a sphere having a center located on said axis of rotation of said casing and offset from said intersecting point in a direction opposite the offset direction of the other of said part spherical regions providing the chamber extending more in the axial direction of said casing than in the direction of the axis of rotation of said pinion gears."

With respect to the Examiner's rejection of Claims 1-6 and 8-10 under 35 U.S.C. 103 as being unpatentable over Applicant Prior Art, Figure 2, in view of Glaze et al. (US 4,733,578), Applicants respectfully submit that neither the Applicant Prior Art, Figure 2, nor the Glaze reference teach, suggest, or infer to combine the relevant teachings of each. Applicant Prior Art, Fig. 2, is directed at a differential mechanism narrower in the rotational direction of the casing 12 in order to serve the purpose of removing the side gear shoulders as previously required in differential mechanisms. Similarly, the primary embodiment of Glaze is directed at a differential mechanism narrower in the rotational direction

of the casing 80 in order to provide maximum spacing between the back surfaces of the side gears along the axis of rotation of the side gears (see Col. 4, lines 4-9). Glaze includes one sentence relating to making the differential wider in the direction of the casing without any teaching, suggestion or inference as to why such a modification is desirable. Since Applicant Prior Art, Fig. 2, specifically teaches away from having a wider differential mechanism in the rotational direction of the casing for the purpose of removing the side gear shoulders, and the Glaze reference does not teach or suggest the desirability of having a wider differential mechanism in the rotational direction of the casing, Applicants respectfully submit the references are not combinable.

Even if combinable, the resulting modified differential does not include all features of Claims 1, 3-6, and 8-10. For example, if Applicant Prior Art, Fig. 2 including sphere centerpoints offset toward the other spheres walls, was modified to include varying radii to make a wider differential mechanism in the rotational direction of the casing, the combined modification does not include all of the features of Claims 1, 3-6 and 8-10.

With respect to Claim 2, the Examiner indicates it would have been obvious to one of ordinary skill in the art at the time the invention was made to select the ratio of the radius of one spherical surface to the offset distance be at 30. However, since neither Iwata, Applicant Prior Art, Fig.2 nor Glaze teach, suggest or infer the features of independent Claim 1 (e.g., "such that said at least one spherical surface is closer to said centerpoint of said at least one spherical surface than said chamber centerpoint.") from which Claim 2 depends, Applicant's respectfully submit that selecting such a ratio would not have been obvious.

Finally, Applicants respectfully submit that Claims 1, 3-6, and 8-10 are in a condition for allowance.

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Prompt and favorable consideration of this response is respectfully requested.

Respectfully submitted,

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Enclosures

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Affidavit of Translator

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This is to certify that I, Seiko Morita, am competent to translate the attached Japanese language document. I further certify that to the best of my knowledge and belief, the attached translation is a true and accurate English translation of the attached Japanese language document.

Seiko Morita

Seiko Morita

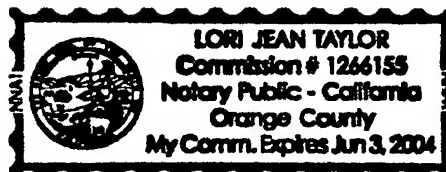
State of California } ss.
County of Orange }

Sworn and subscribed before me

This 13th day of February, 2004

[Signature]

Notary Public



Japan Patent

[54] Differential Gear

[21] Applied 1984 – 269158

[22] Filed Dec. 19, 1984

[72] Inventor Seiichi Iwata, Tokyo Japan

[71] Assignee Fuji Heavy Industry LTD

Abstract

1. Name of the invention Differential Gear

2. Claim Limits

Differential Gear to be designed to support each pinion by forming 4 holes and coaxial spherical seats on four points on the circumference of the cylindrical part of a differential case at intervals of angle of 90 degrees. In case of setting pinions and pinion shafts, pinions and a supporting body are set in the differential case previously, as they have preset positional relations with each other. After that, pinion shafts along the radial direction of this differential case and set fixedly with pins.

3. Detailed description of the invention

[Industrial fields to be applied]

The present invention relates to positioning of pinion shafts and differential case on 4 pinions at differential gear.

[Background of the invention]

Generally, on moving part of vehicle, differential gear is equipped at rotating position like left-right axle. This differential gear is formed with pinion supported by pinion shaft on the differential case engaging the side gear on both left and right side and transfers driving power to the gear at the both side by pinion rotating with differential case, also absorbs the revolution difference. Therefore, the strength of the pinion plays important role. In order to strengthen the pinion, four pinion points on the circumference of the cylindrical part of a differential case at intervals of angle of 90 degrees has been adopted.

[Former mechanism]

Because four pinion shafts are necessary to adopt the above four pinion mechanism, formerly 1 piece cross style spider 1 as indicated at the figure 3 was used and four shafts (1a and 1b) of this spider1 supported 4 pinions (2a and 2d) positioned at intervals of angle of 90 degrees. Then, to make it possible to connect the above cross style spider 1 to the differential case 3, at the center of hole 4 where differential case 3 and spider shafts (1a and 1b) were connected, another connection to the cover 5 was created. Therefore, as shown at figure 3 (b), pinion 2a and 2d were connected to both differential case 3 and cover 5, which created the spherical seats surface (6a and 6b) supporting the back of pinion (2a and 2b) on both differential case 3 and cover 5 continuously.

[Issues the invention is going to solve]

On the above former mechanism, because spherical seats (6a and 6b) were formed on both differential case 3 and cover 5, those needed to be jointed two-dimensionally. Due to some joint error, the spherical seats 6a and 6b might create the gap as shown at figure 3 (b), which cause grinding and burning.

[Remedy for the issue]

The purpose of this invention is to provide the differential gear which can position pinion and spherical seats surface properly by dividing into two away from spherical seats at the differential case in order to resolve the issue on the above former mechanism.

The measure is to support each pinion by forming 4 holes and coaxial spherical seats surface on four points on the circumference of the cylindrical part of a differential case at intervals of angle of 90 degrees. In case of setting pinions and pinion shafts, pinions and a supporting body are set in the differential case previously, as they have pre-set positional relations with each other. After that, pinion shafts along the radial direction of this differential case and set fixedly with pins.

[Function]

Based on the mechanism of the above differential gear, pinion shafts is inserted into the differential case from the outside along the radial direction of the differential case and can support four pinions, which makes it possible that spherical seats along with the holes of shafts is formed only on the differential side without divided and positioning with pinion becomes accurate.

[Implemented example]

Followings are detail description of an implemented example showing on the figures. On the figure 1 and figure 2, number 3 is the cylindrical part of a differential case. The final gear 7 is jointed with the bolt 8 on the flank part of the differential case. On the cylindrical part of a differential case 3, holes 4a-4d and coaxial spherical seats surface 6a-6d are formed on four points at intervals of angle of 90 degrees and the pin hole 18 is overlaid the center of three holes 4a, 4c, 4d . Also at the inner center of the differential case 3, the cross

shaped ditch 9 on the supporting body 10 is overlaid with the hole 4a and 4d on the above differential case 3.

And there is long pinion shaft 11 which is the same length as outside diameter of differential case 3 and 2 short pinion shafts 12, 13. The long pinion shaft is connected to the 2 holes (4b and 4d) on the differential case and cross shaped ditch 9 on the supporting body, then one edge is set with pin hole 18 and pin 14, therefore this pinion shaft 11 makes 2 sets of pinion (2b and 2d) touched to spherical seats surface (6b and 6b) and supported to rotate freely. 2 pinion shafts (12 and 13) is positioned diagonal against the above pinion shaft 11 and aligned with the holes (4a and 4c) on the differential case and cross shaped ditch 9 on the supporting body 10, also fixed with pin 14 to form cross shape. The pinion 2a and 2c are supported respectively by these pinion shafts 12 and 13.

At the point of Pinion at the differential case 3 and the connecting surface A located away from its shaft, the cover is jointed with the bolt 15. At the left and right sides of 4 pinions (2a and 2d) placed at intervals of angle of 90 degrees, the side gears 16, 17 supported by differential case 3 and cover 5 engage on the same axle to transfer the driving power.

The process to assemble pinions and pinion shafts complying with the above structure is to set the pinions (2a and 2d) and the supporting body 10 in the differential case 3 with the required position beforehand, then insert the pinion shafts (11, 12, 13) into from outside of the differential case 3 and fasten them with the pin 14.

[Effect of the invention]

As shown on the above description, this differential gear, whose mechanism is 3 stick pinion shafts are inserted into the supporting body with cross shaped ditch, allows to create spherical seat surface only on the differential case side instead of using the connected surface of the differential case and the cover. Therefore, the gap between spherical seat

surfaces are eliminated and the pinions are positioned on supporting body accurately. The size of the entire space does not need to be changed and the assembly is easy.

4. Brief description of the figures

Figure1 is the vertical sectioned drawing of implemented example for this invention.

Figure 2 is the sectioned drawing of II-II part of Figure1.

Figure 3(a) is the squint drawing of former mechanism.

Figure 3(b) is the sectioned drawing of former mechanism

2a and 2d – pinion, 3 -differential case, 4a and 4d – holes, 6a and 6d – spherical seat surface, 9 -cross shaped ditch, 10 - supporting body, 11- long pinion shaft, 12 and 13 – short pinion shaft

⑩ 日本国特許庁(JP)

⑪ 特許出願公開

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F 16 H 1/40

7331-3J

審査請求 未請求 発明の数 1 (全4頁)

⑮ 発明の名称 差動装置

⑯ 特 願 昭59-269158

⑰ 出 願 昭59(1984)12月19日

⑱ 発 明 者 岩 田 誠 一 東京都西多摩郡瑞穂町石畑8-14

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明 細 書

1. 発明の名称 差 動 装 置

2. 特許請求の範囲

デフケースの内周4ヶ所に孔とそれと同軸上の環面を形成し、該デフケースの内部中心に十字状の孔を有する支持体を配設し、棒状の長い1本のビニオンシャフトを径方向の2つの孔と支持体の孔に嵌合して固定し、該ビニオンシャフトにより2個のビニオンシャフトと直交する方向で、デフケースおよび支持体の孔に嵌合して固定することで、それぞれビニオンを1個ずつ支持することを特徴とする差動装置。

3. 発明の詳細な説明

【産業上の利用分野】

本発明は、4ビニオンの差動装置に関し、特にビニオンシャフトとデフケースの組付け構造に関するものである。

【発明の背景】

一般に車両の駆動系において、左右の車輪のよう

に、この差動装置は、デフケース側のビニオンシャフトに回転自在に支持されたビニオンが左右のサイドギヤに噛合して成り、ビニオンがデフケースと共に回転しながら自転して駆動力を両サイドギヤに伝達し、かつ回転差を吸収するようになっている。従って、ビニオンの設置が大きく、その強度的な点が重視されるのであり、かかるビニオンの強度アップを図るため、ビニオンをデフケースの内周上に90度間隔で4個設置した4ビニオンの機構が採用されるに至っている。

【従来の技術】

ところで、上記4ビニオン機構を採用する場合は、ビニオンシャフトも4本必要になることから、従来は第3図に示すように十字状の一体形スパイダ1を用い、このスパイダ1の4本のシャフト1aないし1dで、90度間隔の4個のビニオン2aないし2dを支持する構造になっている。そして上記十字状スパイダ1のデフケース3への組付けを可能にするため、デフケース3のスパイダシャフト1aないし1dと嵌合する孔4の中心にカバー5との接

合面Aを設けた2つ割り構造を成す。このため、第3図例に示すようにビニオン2aないし2dは、デフケース3とカバー5の両者にまたがって設置されることになり、このことからビニオン2aないし2dの背部を支持する球面座半部8a, 8bが、デフケース3とカバー5の両者に連続的に形成されている。

【発明が解決しようとする問題点】

しかるに、上記構成のものにあっては、デフケース3とカバー5の両者に球面座半部8a, 8bが形成されているので、組付け時にそれを二次元的に合わせる必要がある。この場合に加工誤差により、球面座半部8a, 8bが上記第3図例のように段差を生じることがあり、これに伴い座面のカブリ、焼付等を招くという問題がある。

【問題点を解決するための手段】

本発明は、上記従来技術における問題点に鑑み、デフケース側球面座から外れた箇所を2分割するように構成して、ビニオンと球面座の位置決めを的確に行い得るようにした駆動装置を提供するこ

とを目的とする。

その手段は、デフケースの円周4ヶ所に孔とそれと周軸上の球面座を形成し、該デフケースの内部中心に十字状の孔を有する支持体を配設し、棒状の長い1本のビニオンシャフトを径方向の2つの孔と支持体の孔に嵌合して固定し、該ビニオンシャフトにより2個のビニオンシャフトと直交する方向で、デフケースおよび支持体の孔に嵌合して固定することで、それぞれビニオンを1個ずつ支持することを特徴とするものである。

【作 用】

上記駆動装置の構成に基づき、ビニオンシャフトはデフケースの径方向から挿入して内部で十字状に組合わせ、かつ4個のビニオンを支持するように組付けことが可能となり、これによりシャフトの孔と共に球面座をデフケース側のみ分割することなく形成して、ビニオンとの位置決めを的確に行い得るものである。

【実 施 例】

以下、本発明の一実施例を図面に基づいて具体

的に説明する。

第1図と第2図において、符号3は図状を成すデフケースであり、そのフランジ部にファイナルギヤ7がボルト8により一体的に結合される。デフケース3の円周部において、円周上の90度間隔の4ヶ所には孔4aないし4dと、それと周軸上の球面座8aないし8dが形成され、3ヶ所の孔4a, 4c, 4dの中心には、径方向にピン孔18が貫通して穿設される。またデフケース3の内部中心には、十字状の孔9を有する支持体10が、その十字状の孔9の方向を上記デフケース3側の孔4aないし4dと一致させて設置される。

一方、デフケース3の外径と略等しい棒状の長い1本のビニオンシャフト11と、短い2本のビニオンシャフト12, 13を有し、長いビニオンシャフト11が、デフケース3の径方向の2つの孔4b, 4dと支持体の十字状の孔9に嵌合し、一端をピン孔18のピン14で固定して設置され、このビニオンシャフト11により2個のビニオン2b, 2dが、背部を球面座8b, 8dに接触して回転自在に支持される。

また上記ビニオンシャフト11に対し直交する方向で、2本のビニオンシャフト12, 13が、デフケース3の孔4a, 4cと支持体10の十字状の孔9に嵌合して突出しをし、かつピン14で固定して十字状に組合わされ、これらのビニオンシャフト12, 13でビニオン2a, 2cが1個ずつ同様に支持される。

そしてデフケース3のビニオンおよびそのシャフトから外れた箇所の接合面A'で、カバー5がボルト15により締結されている。更に90度間隔で配設された4個のビニオン2aないし2dの左右には、デフケース3とカバー5で支持されたサイドギヤ16, 17が、周軸上に啮合して伝動構成される。

上記構成により、ビニオンおよびビニオンシャフトを組付ける場合は、デフケース3の内部にビニオン2aないし2dおよび支持体10を、所定の配置関係であらかじめ入れておく、そしてビニオンシャフト11, 12, 13をデフケース3の外から径方向に内部に挿入し、ピン14にてピン止めすることで組付けられる。

【発明の効果】

以上の説明から明らかなように、本発明の差動装置によれば、棒状の3本のビニオンシャフトを、十字状の孔を有する支持体を用い十字状に組合わせて、4個のビニオンを支持するように組付けられるので、デフケースとカバーの接合面を利用しなくとも、デフケース側のみ差動差を形成することができる。このため、差動差の製造による不具合は排除され、ビニオンとの位置決め、即ちその支持を的確に行い得る。全体のスペースを減える必要がなく、組付けも容易である。

4. 図面の簡単な説明

第1図は本発明による装置の一実施例を示す縦断面図、第2図は第1図のII-II断面図、第3図は従来例を示す側視図、第3図は同一部の断面図である。

2aないし2d—ビニオン、3—デフケース、4aないし4d—孔、5aないし5d—差動差、6—十字状の孔、10—支持体、11—長いビニオンシャフト、12、13—短いビニオンシャフト。

